Diagnosing APD: findings from a population study of auditory processing

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The auditory brain

Ear → Central Auditory System → Hearing
The auditory brain

“It’s not what you hear, it’s what you do with what you hear”
Jack Katz
Clinical presentation of auditory processing disorder

- Difficulties hearing in noisy surroundings
- Difficulties following verbal instructions
- Language difficulties

- Inattention
- Distractibility
- Communication difficulties
- Academic difficulties

(Keith, 1994, 2000; Bamiou et al, 2001)
APD symptoms are similar to other developmental disorders

Dyslexia

Autism

Behavioural problems

Specific Language Impairment

Attention Deficit Hyperactivity Disorder
To develop a short clinical test battery to diagnose APD

Need:

• Definition

• Sample

• Tests
Definition

British Society of Audiology (2007)

“results from impaired neural function and is characterised by poor recognition, discrimination, separation, grouping, localisation, or ordering of *non-speech* sounds.

It does not result from a deficit in *general* attention, language or other cognitive processes”.

- ASHA (2005)
- NIDCD (2001)
Sample

- Case control approach
  Examine two samples of listeners, one with and one without diagnosed APD

  Addresses the ‘clinical presentation’

- Assumes existing knowledge of diagnostic method
  Assumes unbiased sampling of APD (and control) group
Sample

- Population approach
  Poor auditory performance is identified on the basis of auditory/non-speech abilities, not symptoms

- Makes no assumption about the link between presenting symptoms and APD

- Can lose track of clinical presenting symptoms

Prevalence of APD unknown, estimate 5%
Tests

- In the UK there are currently no validated or standard tests to diagnose APD.

- Those available are based on a clinical case approach:
  - often without an auditory basis.

- Only 12% of UK Audiology services diagnose APD:
  - those that do use many tests
  - n=36 (Hind, 2006)
Challenges of APD

- Difficult to identify APD from other developmental disorders
- Lots of clinical tests of APD available
  - many of these are:
    - based on a clinical case approach
      - where test results from those suspected of having APD are used to authenticate the test’s diagnostic utility
    - poorly validated
    - speech-based
      - leading to confusion with language-based impairments
- Results in confusion and uncertainty for audiologists in the diagnosis of APD
- **Solution**: Need for robust research to understand what APD is, how it is characterised, then how it can be diagnosed and managed
IHR Multi-centre Auditory Processing study (IMAP)

Population study, May 07-July08
n = 1638 children, 6-11 y.o.
Stratified by age, sex and socioeconomic group

Nottingham
Exeter
Glasgow
Cardiff

RA based in audiology dept
Testing in schools
IMAP Aims

- To normalise auditory processing data
- To obtain profiles of APD
- To obtain prevalence of APD
- Standardised diagnostic test for APD
Computer game display

3I-3AFC; adaptive, oddball paradigm, feedback

Well done!

Threshold determination uses adaptive, staircase method
Tests of Auditory Processing

Temporal Resolution

- (Backward masking without gap)
- (Backward masking with 50 ms gap)

Frequency Resolution

- (Simultaneous masking without spectral gap)
- (Simultaneous masking with 400 Hz spectral gap)

Frequency Discrimination

- 20 ms 1 kHz tone
- 200 ms 1 kHz tone
- Noise
- Quiet
Tests of Auditory Processing

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- Frequency Discrimination

Individual tests = sensory + non-sensory factors

Tests UofUAuditoryUProcessing

- Noise
- Quiet

- 20 ms 1 kHz tone
- 200 ms 1 kHz tone

MRC | Medical Research Council
Temporal Resolution

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(Backward masking with 50 ms gap)

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Frequency Discrimination

- 20 ms 1 kHz tone
- 200 ms 1 kHz tone
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- Quiet

Derived tests = sensory
Non-sensory factors cancelled out
IMAP test battery

- Hearing thresholds
  - 1 and 4 kHz

- Speech intelligibility
  - VCV in ICRA-5

- AP tests
  - Freq. discrimination
  - Freq. resolution
  - Temp. resolution

- Cognitive
  - Nonverbal IQ
  - Non-word repetition
  - Memory
  - Literacy

- Attention:
  - Auditory
  - Visual

- Parent Qaires
  - CCC-2
  - CHAPS

- 1 hour!
Preliminary results

n=1471
Normally hearing children
(≤ 20 dB HL)
Summary to date

- Poor auditory perception
  - poor performance on the derived measures of AP
    - did not explain poor performance on the speech-in-noise (SiN), cognitive or communication tests

- Poor auditory cognition (e.g. memory, attention)
  - poor performance on the individual measures of AP
    - related modestly to performance on the SiN, (general) cognitive and communication tests

- Suggests APD is not a pure sensory processing problem but a cognitive problem.
Performance pattern - response variability

'Good performer'

'Genuine poor performer'

'Non-compliant'

Frequency difference (Δ% Hz)

Trials

Trials

Trials

Frequency discrimination: 8-9 y.o.

(Moore et al, Hear Res, 2008)
Where to next?

- Lots of data!!
- Further analysis
  - response patterns
  - how AP relates to cognition including attention
  - individual data
- Better understanding of auditory processing and APD
  
  short, clinical test battery of APD
Summary and conclusions

• Unlike most other APD research we have taken a population approach.

• APD does not appear to be a result of poor sensory processing as evidenced by frequency or temporal resolution.

• Impaired auditory cognition may contribute to APD, but further analysis of our data is needed to get a better understanding of APD.

• Aiming for an APD test battery for use in further NHS clinical trials next year.
IMAP team

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Thank you

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Commonly asked question

“even if we are able to diagnose APD in children, how do we best manage them?”
Auditory training improves language in typically developing children

Phonological Assessment Battery
(rhyme, alliteration, spoonerisms, non-word reading)

<table>
<thead>
<tr>
<th>Time of test</th>
<th>Training</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre (pre-training)</td>
<td>9±1</td>
<td>9±1</td>
</tr>
<tr>
<td>Post (4 weeks training)</td>
<td>11±1</td>
<td>11±1</td>
</tr>
<tr>
<td>Delayed (5-6 weeks later)</td>
<td>12±1</td>
<td>12±1</td>
</tr>
</tbody>
</table>

p<0.0001

(Moore, Rosenberg and Coleman, Brain Lang. 2005)